The coming collision between automated instruction and social constructivism

David Wiley, Ph.D.
Department of Instructional Technology
Utah State University
david.wiley@usu.edu

Introduction

There are currently two groups of individuals in instructional technology research which are pursuing a research agenda aimed at making education scale to very large numbers of students and improve in effectiveness. These two groups are pursuing almost orthogonal paths.

After years of trying to preserve the traditional classroom teacher-to-student ratio in online instructional settings, the first group surmised that including humans in the instructional feedback loop simply makes instruction too expensive. To work around this bottleneck, these researchers employ technology in the form of reusable educational resources ("learning objects") and automated instructional ("intelligent tutoring") systems. The role previously filled by teachers (providing feedback and scoring assignments) is filled by computer, and the computer can support as many students as its resources permit.

Another group of instructional technology researchers are championing sociocultural approaches to learning, specifically interested in the role of community in learning, claiming that human-to-human interactions are not niceties that make learning more interesting or fun, but that every kind of learning but simple rote memorization requires complex social negotiations and structures to support the development of meaningful understanding. Technologies employed by these researchers include Wikis, Blogs, and other democratic collaborative media.

These two groups are walking down diverging paths, the first toward driving humans out of the instructional loop, and the second toward adding more humans to the instructional loop. This chapter explores these research paths in more depth and proposes a manner in which they may be reconciled.

Learning objects

A "learning object" is "any digital resource that can be reused to mediate learning" (Wiley & Edwards, 2002). The two main goals behind learning objects research and development are:

1. To improve the economics of online instruction, and

2. Enable pedagogical innovation.

These two goals may not be equal in importance in the minds of learning objects researchers. Each is described in more detail below.

Improving the economics of online instruction

When instruction first moved online, the traditional classroom model of instruction went with it, including assumptions from the face-to-face realm about the ideal teacher-to-student ratio. As online offerings filled up, the Open University and others devised plans to hire armies of Teaching Assistants to preserve this ratio and provide much needed learning support to individuals taking online courses. Eventually it was discovered that this model did not scale well to the large numbers of learners, especially for the very large numbers for-profit instructional development firms hoped to reach.

From this point of view, having a human in the loop is a severe bottleneck. For years proponents of online instruction have declared that "once we have enough bandwidth" online education will really take off, with two-way interactive video, etc. As it turns out, "teacher bandwidth," or the number of students an individual teacher can service, turns out to be the most significant bottleneck in the online learning space. Like much of the CBI research before it, learning objects research has been filled with individuals describing varying ways in which automated systems can take the human out of the loop while still providing the necessary learning support to individual students (e.g., Martinez, 2002; Merrill, 2002; Hodgins, 2002). Like other pieces of software, this step to an automated system, which can be sold and distributed electronically, moves instructional technology companies into the area of "write it once, sell it often" economics which has transformed companies like Microsoft and Oracle into commercial powerhouses. This interest is represented by a statement of purpose from the IEEE's *Learning Technology Standards Committee*'s Learning Objects Metadata specification:

> To enable computer agents to automatically and dynamically compose personalized lessons for an individual learner.

Complaints regarding economically-improved online instruction generally center around notions of learner isolation and the dehumanization of learning. Wiley and Edwards summarized, "Why would we put learners in front of the most advanced communications system of all time and not have them communicating?" (Wiley & Edwards, 2002).

Enable pedagogical innovation

A secondary interest in learning objects is the ability to build new pedagogies on top of the learning objects platform. While several groups have claimed innovation

within the area of instructional approaches facilitated by the use of learning objects, all of these claims have in fact brought existing "alternative" pedagogies to online learning, and the innovation has been technical in the nature of the automation of the pedagogy (e.g., "pre-test and omit" in L'Allier, 1998; "discovery and inferential learning" in Sonwalkar and Arnone, 2002). Little truly innovative work has occurred in the pedagogical realm to date that can be credited to the existence of learning objects. However, such novel work remains a goal of some members of the movement.

Learning communities

Because research indicates the human-to-human interaction increases retention of information and skills learned (e.g., Clark, 2002), and decreases drop out rates in online courses (e.g., Shea & Boser, 2002), there has recently been significant emphasis on adding social interaction to online courses. From popular sources such as John Seely Brown's *The Social Life of Information* to academic works like Lave and Wenger's *Communities of Practice*, more and more researchers are positing that social interaction isn't an option that makes learning fun, it is necessary condition for effective learning to occur. Generally there have been two means of promoting this social interaction in online courses:

1. Requiring student-to-student interaction (generally in the form of web board or other threaded discussions), and
2. Requiring teacher-to-student interaction (whether in weekly chats or by e-mail or web board).

Requiring student-to-student interaction

Students in university programs will likely graduate into jobs requiring them to function as problem-solvers in the context of a project team (Jonassen, 2002). In order to keep the context of practice as close to the context of performance as possible, it is important for students to learn to work as members of collaborative teams. Meaningful collaborative assignments pull real-world problems out of authentic contexts. A significant portion of this authenticity is that these problems are too complex for individuals to solve, requiring students to collaborate to succeed in problem-solving and learning.

Unfortunately the majority of requirements for student-to-student interaction in online courses seem to stem from the idea that collaboration is "the thing to do." Even well-structured collaborative assignments for online students can be subverted in a number of ways if attention is not paid to a significant number of extracurricular variables (e.g., students that have other outlets for communication such as regular face-to-face meetings for other courses will frequently perform their collaboration in these higher bandwidth

channels). In other words, using online collaborative assignments effectively is “really hard” in online courses as current conceived.

Requiring teacher-to-student interaction

Teachers of online courses frequently require students to participate in regular synchronous chats or asynchronous discussions in which the teacher takes part. The teacher is available to answer questions related to course content, process / administration, and technical difficulties (as their skills permit).

Unfortunately, requiring students to show up for synchronous interactions removes many of the benefits that lead students to sign up for online courses in the first place. Additionally, a policy or culture of providing every student with multiple individualized accesses to an instructor over the duration of the course forces class sizes to be very small, ensuring that we never experience a qualitative change in the number of students we are able to serve even when we employ instructional technology.

The Coming Collision

While they may not realize it, the learning objects community (as exemplified by specification bodies like IEEE, SCORM, and IMS and corporations like NetG and Click2Learn) and the learning communities group (as represented by individuals like David Carter-Todd, David Davies, and David Wiley) are on a collision course, as represented in Table 1.

Table 1. Two R&D Communities, Their Primary Goals, and Means of Achieving Them

Community	Learning Objects	Learning Communities
Primary Goal	Make learning as scalable, economically viable, and effective as possible	Make learning as scalable, economically viable, and effective as possible
Primary Means of Achieving Goal	**Automation: Design to remove humans from the loop**	**Collaboration: Design to bring humans into the loop**

In an ideal world the goals of the research camps whose aims are making instruction as efficient as possible and as effective as possible would not be at odds with one another. However, in terms of the means of reaching these goals, the research communities seem to be drifting further apart from each other.

Such a rift in the field of Instructional Technology harkens back to the days of the Instructivist / Constructivist debates, during which more time was spent defending fiefdoms than working to integrate valuable contributions into a pragmatic superstructure which would provide Voltaire's "best of all possible worlds."

The remainder of this chapter explores an integrative framework that brings many of the valuable components of the learning objects movement together with many valuable contributions from the body of research around learning communities.

Decentralized Learning Communities

The Internet provides multiple examples of very large groups of people (30,000+) who work together to support each other in their own learning, employing reusable digital resources as the main building block of their efforts. In other words, these groups have found a way to create a hybrid learning objects driven-learning communities model, which only required one "small" change in the overarching educational superstructure: the deconstruction of centralized control. Two mini-cases are presented as examples of the types of systems implied, followed by a discussion of the characteristics of the integrative framework.

Mini-case 1: Slashdot (http://slashdot.org/)

This case is taken from Wiley and Edwards (2002).

Slashdot is a news site, carrying stories of interest to "geeks" and "nerds." Frequent topics include bleeding edge hardware and software developments, intellectual property law and lawsuits, Japanese anime, and reviews of science fiction books and movies. Users contribute "news stories" – which are frequently summaries of stories, reviews, and other information found on other sites across the web, along with links to the original content – for the editors to approve. Editors review the material for appropriateness (alignment with Slashdot's content areas) and originality (is this story already running on the front page?) and then either approve or discard the submission. Accepted submissions run in a box on the site's front page (see Figure 1), and each story box contains a link to an area where threaded discussion dedicated to the story occurs (see Figure 2).

Figure 1. A screen capture of the Slashdot website located online at http://slashdot.org/

The threaded discussion itself is equally interesting. Community members meeting certain criteria have the ability to "moderate" or evaluate the quality of individual comments. These evaluations are aggregated to produce scores from –1 ("Flamebait") to 5 ("Insightful"). Using these comment ratings and an infrastructure that dynamically generates HTML, Slashdot allows users to set thresholds for the quality of comments to which they want to be exposed. Generally speaking, I have found that using the website with this threshold set at 4 or higher is an intellectually satisfying experience (see Figure 2).

"Meta-moderation" allow other members of the community to evaluate the appropriateness of moderators' ratings. For example, if a moderator with an axe to grind against Microsoft moderated an informative comment regarding the XP operating system down to –1, meta-moderators would mark this moderation as "Unfair." This system of meta-moderation provides the larger community a powerful balance against "the tyranny of the moderators."

The combination of Slashdot's moderation system with its meta-moderation system creates a powerful infrastructure for *real-time peer review*. This infrastructure supports the community's efforts to bring the best information, questions, and answers to the attention of the community, while making it difficult for misinformation and half-baked ideas to propagate across the network. In short, it functions much like the peer review process that provides the gateway to academic journals. It impressively fills this role a) in real-time, b) with input from a larger proportion of the community, and c) with meta-moderation checks in place to prevent abuse.

Figure 2. A screen capture of the Slashdot website showing the total of all comments and those comments above the quality threshold.

Mini-case Two: kuro5hin (http://kuro5hin.org/)

Kuro5hin (K5) is similar to Slashdot in many respects: users submit questions and content to appear on the site, users participate in threaded discussions regarding individual pieces of content, and users rate the quality of each other's comments. The K5 infrastructure differs from Slashdot in two important ways:

1. Question, stories, and other material submitted to K5 are accepted or rejected based on open review by the entire community, not a handful of editors, and
2. Comments on K5 are typed: some are topical (comments about the opinions expressed in a story, answers to a question asked, etc.) and others are editorial.

These architectural differences manifest themselves in significant differences in the culture and practice of the K5 and Slashdot communities. For example, editorial comments frequently point out weaknesses in arguments, typographical errors, and provide a host of other editorial functions. This has lead to a culture on K5 that values well-developed writing; as a consequence, the average story on K5 is significantly longer than that on Slashdot. Recent stories such as a 3500-word exposition of String Theory for beginners, or the 2200-word Geek's Guide to Brain Chemistry are exemplary of this trend.

Characteristics of Decentralized Learning Communities Pertinent to Learning Environment Design

Decentralization of power

If these communities and others like them (e.g., http://perlmonks.org/) don't seem like any online course you have ever seen, it is because they aren't online courses. The biggest difference between these communities and courses is that these communities are

decentralized, meaning there is no one with a syllabus or other agenda telling the community, "today you're going to learn about this." The notion of us and them, or expert and novice, is decentered (Wilson & Ryder, 1998), and expertise lives in the community rather than in a super-person vested with authority in a manner asymmetric with their peers (Hewitt & Scardamalia, 1996). This is why real-time peer review is a key component of these systems.

As with offline communities of practice, these online communities are not engaged in "just talking about" content, but are engaging in practice as a group. The majority of the activity involves the discussion and solution of real-world problems, selected by the participants from their every day lives – as authentic as the contexts for problems get. In addition to work in their content areas, each of the communities is more or less aware of their existence as online learning communities, and (particularly members of K5 who dedicate an entire section of the web board to "Meta" discussions about K5) are reflexive in their participation.

Again, the key difference between the ability of decentralized learning communities (DLCs) and traditional courses to integrate both learning objects and learning communities research lies in the DLC's distribution of power. A useful comparison can be made between the power structures in traditional online courses and those found in decentralized learning communities, as in Figure 3, with some language borrowed from the political lexicon.

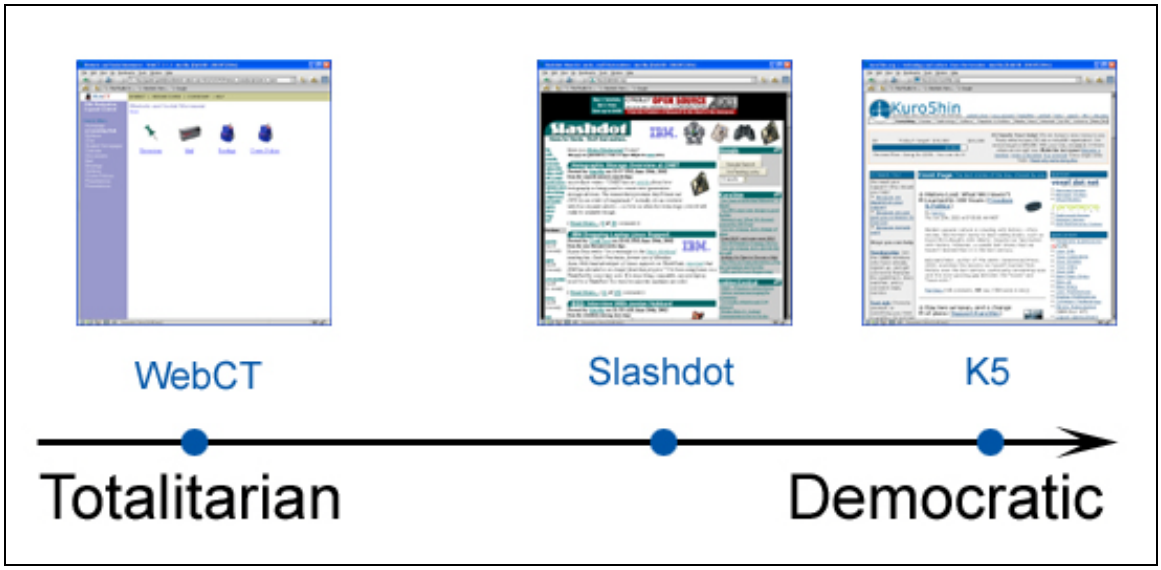

Figure 3. A continuum representing the centralization of power in online learning environments.

In formal (higher ed / corporate training) learning environments, power over what will be studied, the sequence of study, what counts as exhibition of mastery, to what extent it must be displayed, etc., is controlled by one individual: the teacher, trainer, or designer of

the automated system. Some teachers attempt to share power with students (which of these five topics should we study next week?), just as some systems allow learner control in the sequencing of some of the content, but the power structure of the situation is always asymmetric – with the vast majority of participants on the bottom end. Along these same power lines, Wertsch (1998) has argued that speaking with the authoritative voice typical of teachers quashes critical thinking and prevents the construction of new knowledge.

Finding, using, and creating learning objects as a community

The manner in which DLCs reap the benefits of learning communities research is rather obvious, but how to they take advantage of reusable educational resources, ala learning objects, without central repositories, standardized metadata with controlled vocabularies, etc? Wiley and Edwards (2002) provide the follow list of the way members of these communities find, utilize, and evaluate learning objects:

- Indexing and Discovery: Learning objects are not cataloged with metadata and submitted to a central curator repository. Community members know of existing resources and local resource collections. Individual resources are discovered through "community queries" in which community members respond with pointers to resources they know about personally. When a sufficient portion of the community responds in this manner, the learner locates satisficing resources.
- Combination: Learning objects are not automatically populated into one of many instructional templates. Without the direction of any single grand architect, peers contribute relevant resources and descriptions of how they might be employed within the context of the initiator's problem. Much like a colony of ants, peers autonomously build on one another's work and create a satisficing resource structure without centralized direction (Bonabeau, Dorigo, & Theraluaz, 1999).
- Use: Learners do not sit through a temporal sequencing of resources and assessments linked to decontextualized instructional objectives. They employ resources provided by peers as mediational means in the solution of a self-selected problem or accomplishment of another self-selected goal.
- Evaluation: Learning objects are not critiqued out of an instructional context; learners evaluate the relevance and suitability of resources within a specific learning context. (Williams, 2002) contains an excellent description of the impasse created by attempting to apply current context-dependent evaluation methodologies to extremely decontextualized educational resources.)

Implicit in this discussion is the creation and design of new learning objects. Any software infrastructure that captures conversations and exposes them to later search and linking (reuse) allows members of communities such as K5 to participate in knowledge creation. These threaded conversations are highly contextualized learning objects of just the right grain size for later reuse by the community, or within formal educational contexts.

Landmarks and port towns

Landmarks of important historical significance receive hundreds of thousands of visitors each year. However, these individuals return rarely, if at all, because the "content" of the site never changes. Because they do not interact regularly, these individuals never transform into a community *per se*. Personally, I've been to Mt. Rushmore twice, loved it, and will probably go again. But I doubt I'll ever form any lasting relationships with the people I meet there.

Port towns, on the other hand, receive constant shipments of the newest, latest, and greatest, as well as the necessities. People from around the region visit port towns regularly, week after week, picking up the things they need. In areas like this where there are multiple opportunities for interactions among the same individuals, community can emerge. And so it is online.

A few years ago I edited a book about learning objects, posted the contents of the book online for free, and made a meager attempt to build a learning objects community around the book. The community portion of the project failed miserably, because the book was a landmark: never any new content, never any reason for people to return. Each of the DLCs described above thrives because there is a substantial amount of new content, questions, and other dialogue prompts posted regularly.

Distribution of labor

It takes a significant amount of effort to make a community thrive. In the initial stages when the community is small, individuals must shoulder huge amounts of responsibility. However, as the community grows in size, additional people can be recruited to be responsible for smaller and smaller units of work, as the work/users ratio decreases. The relationship between the number of community members and the community-sustaining work for which each is responsible is depicted in Figure 4.

Knowledge Sharing

Restricting access to individuals' expertise, information, and resources does not promote the development of a DLC. Whatever the incentive structure may be that inspires individuals to freely offer up 3,500-word expositions on theoretical physics, they have to continue to do so, and share the results freely with one another. The economics of the DLC port town are still unclear and a matter of much research (e.g., http://opensource.mit.edu/); nonetheless, "free and open access" is the mantra by which the communities live and die. This is because any kind of restriction decreases the amount of goods available in the port town, or the number of store open in the mall, or what have you. People will simply not come if there is no value in going.

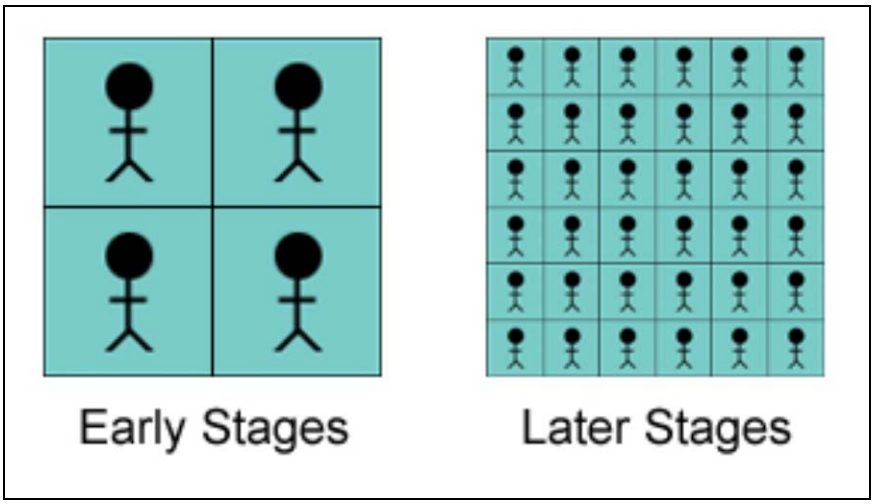

Figure 4. The relationship between work unit size and number of community members.

While not yet a DLC, this thinking is best exemplified by MIT's OpenCourseWare initiative (see http://web.mit.edu/ocw/). This bold initiative will eventually put the instructional content (lecture notes, syllabi, problem sets and exercises, etc.) from every MIT course online for free, available to anyone, for any use. MIT obviously recognizes that the institution's primary value is not in its content as much as it is in the social interactions that it facilitates. Once these materials become available (beginning Fall 2002), we can expect to see massive DLCs spring up around them to support informal learning that re-utilizes the materials.

Summary

There is the potential for a great rift to occur in e-learning between those looking to remove social interaction from courses and those looking to add more social interaction to the experience. Decentralized learning communities provide one way of bringing together the best of each of these approaches. Of course, the Gagne Assumption that different types of content will have different optimal methods of instruction continues to hold, and DLCs are not the best instructional approach in every instance. But they have already proven successful "in the wild," and there is much for instructional designers to learn about the ways in which online learning can be **both** scalable **and** social.

Reference List

Bonabeau, E., Dorigo, M., & Théraulaz, G. (1999). *Swarm intelligence: From natural to artificial systems*. New York: Oxford University Press.

Clark, D. (2002). The pros and cons. Retrieved June 12, 2003, from http://www.nwlink.com/~donclark/hrd/elearning/proscons.html

Hewitt, J. & M. Scardamalia (1996). Design Principles for the Support of Distributed Processes. Symposium on Distributed Cognition: Theoretical and Practical Contributions, American Educational Research Association Annual Meeting. New York, NY.

Hodgins, W. (2002). The future of learning objects. Retrieved June 12, 2003, from http://www.reusability.org/read/chapters/hodgins.doc

L'Allier, J. J. (1998). NETg's precision skilling: The linking of occupational skills descriptors to training interventions. Retrieved June 12, 2003, from http://www.netg.com/research/whitepapers/pskillpaper.asp

Jonassen, D. H. (2002). Toward a Meta-Theory of Problem Solving. Retrieved June 12, 2003, from http://tiger.coe.missouri.edu/~jonassen/Design%20Theory.pdf

Martinez, M. (2002). Designing learning objects to mass customize and personalize learning. Retrieved June 12, 2003, from http://www.reusability.org/read/chapters/martinez.doc

Merrill, M. D. (2002). Knowledge objects and mental models. Retrieved June 12, 2003, from http://www.reusability.org/read/chapters/merrill.doc

Shea, R. H. & Boser, U. (2002). Locating quality. Retrieved June 12, 2003, from http://www.justcolleges.com/elearn/index.phtml?el=locating.htm

Sonwalkar, N. & Arnone, M. (2002). Logging in with… Nishikant Sonwalkar. Retrieved June 12, 2003, from http://chronicle.com/free/2002/03/2002030401u.htm

Wertsch, J. V. (1998). Mind as Action. Cambridge: Cambridge University Press.

Williams, D. D. (2002). Evaluation of learning objects and instruction using learning objects. Retrieved June 12, 2003, from http://www.reusability.org/read/chapters/williams.doc

Wilson, B. & Ryder, M. (1998). Distributed learning communities: An alternative to designed instructional systems. Retrieved June 12, 2003, from

http://carbon.cudenver.edu/~bwilson/dlc.html